Development of Surface Crack and Corrosion Pit Fatigue Crack Growth Threshold Region Data

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Overview

Principal tasks:

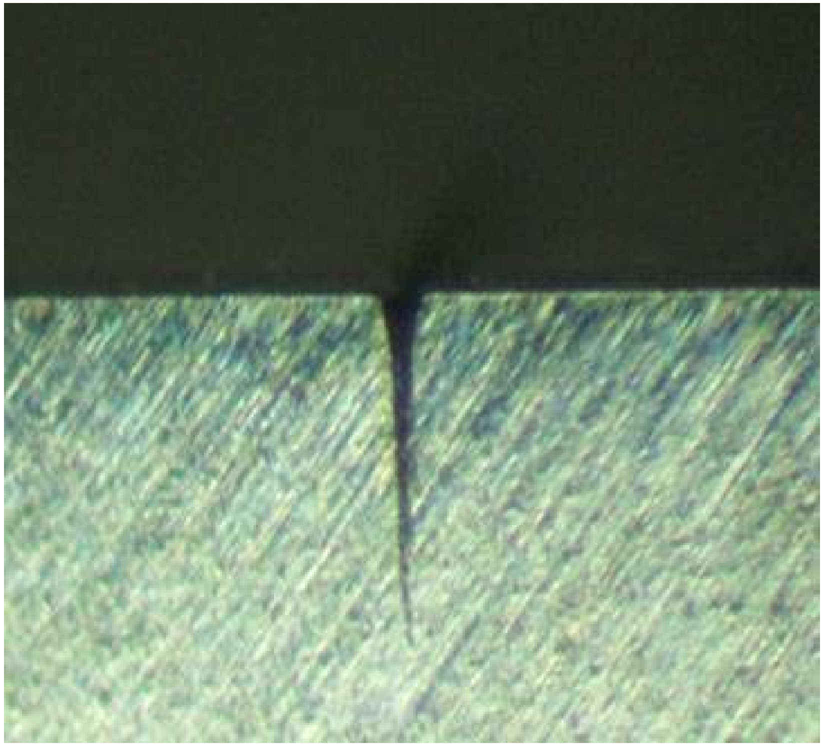
- **Develop surface crack and corrosion pit threshold data**

Surface Crack and Corrosion Specimens

- High cycle fatigue systems are prone to mechanically-induced surface cracks and corrosion pitting
- Components are shot-peened to retard surface crack growth
- How do these surface cracks and corrosion pits behave with respect to published, standardized crack growth data?

Creating Surface Cracks

- Laser etching used to put in surface cracks
  - Photo is 0.012 inches in depth
  - Semi-circular surface crack
- Photos and surface crack information provided by Aaron Nardi, Hamilton Sundstrand Corp.



12.5 mil Deep Surface Crack

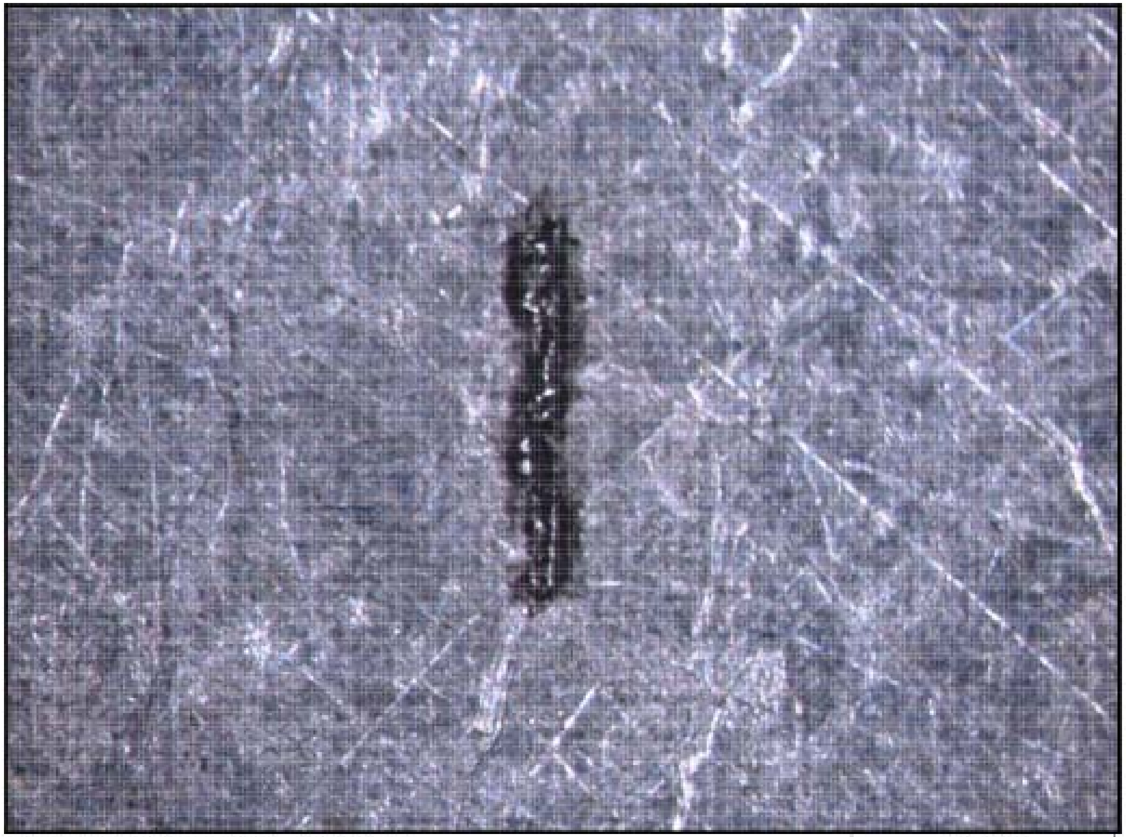


Photo #: 0604A00340, 060419-1, , 20 mils

Comment: Sample with CCAT parameter set from April 19, 2006. Using cutting parameters of 20 khz frequency, 25 pulse width, 100 mm/s, and cleaning parameters of 80khz pulse frequency 2.5 pulse wic and 500 mm/s. 2 cutting passes then 1 cleaning pass. Incrementing down in length and up in power v sucessive passes.

Making the 12.5 mil deep Crack

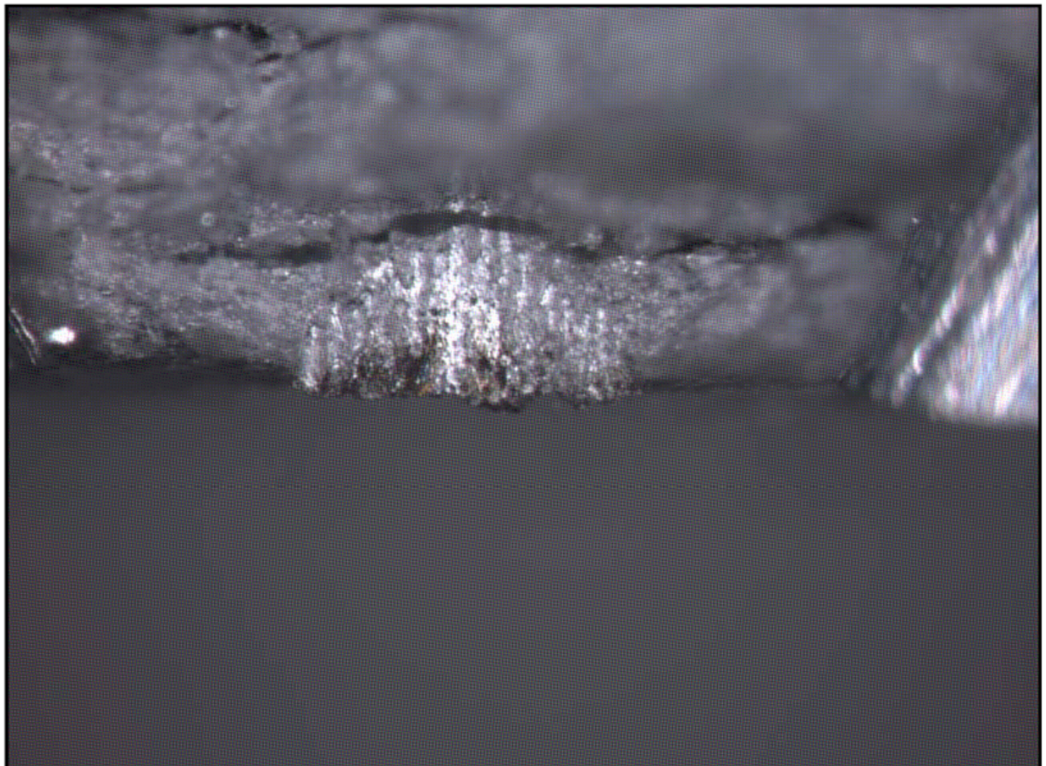


Photo #: 0604A00343, 060419-1 ,, 20 mils

Comment: Sample with CCAT parameter set from April 19, 2006. Using cutting parameters of 20 khz frequency, 25 pulse width, 100 mm/s, and cleaning parameters of 80khz pulse frequency 2.5 pulse wic and 500 mm/s. 2 cutting passes then 1 cleaning pass. Incrementing down in length and up in power v sucessive passes.

Centerline of Crack

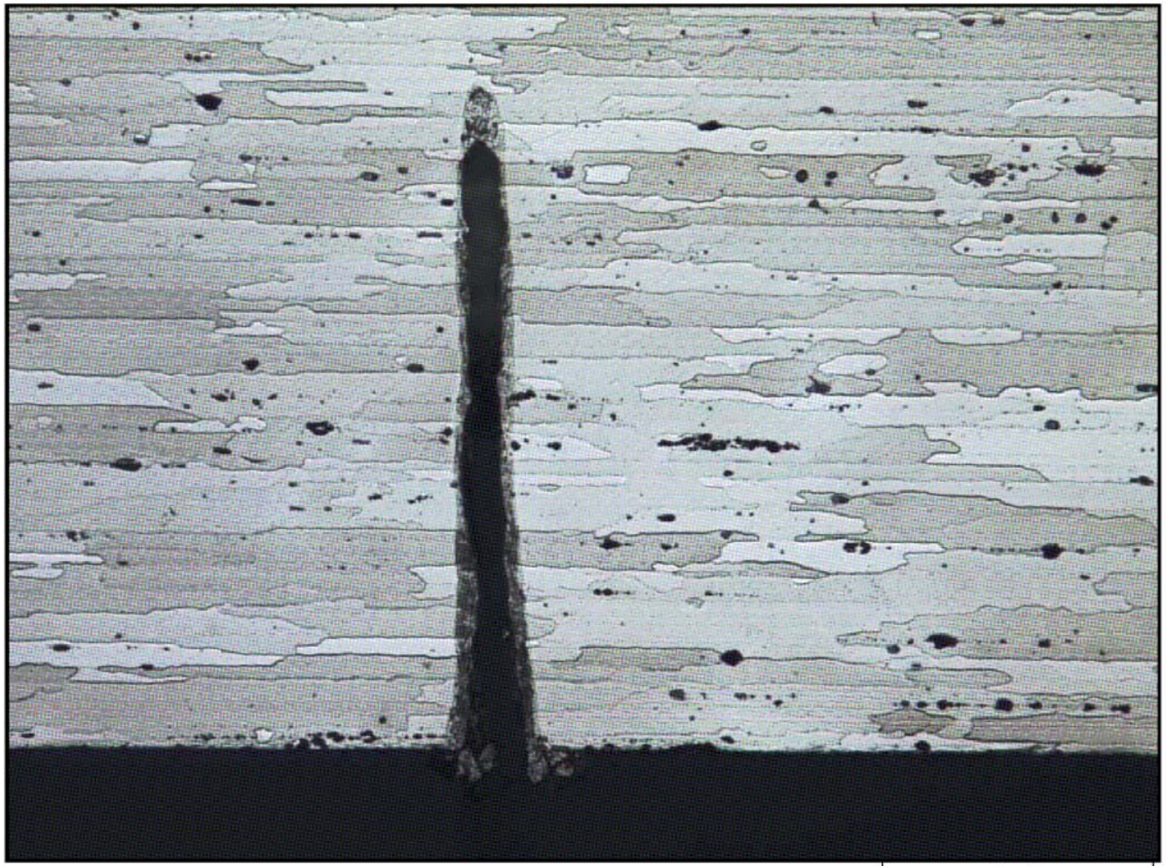


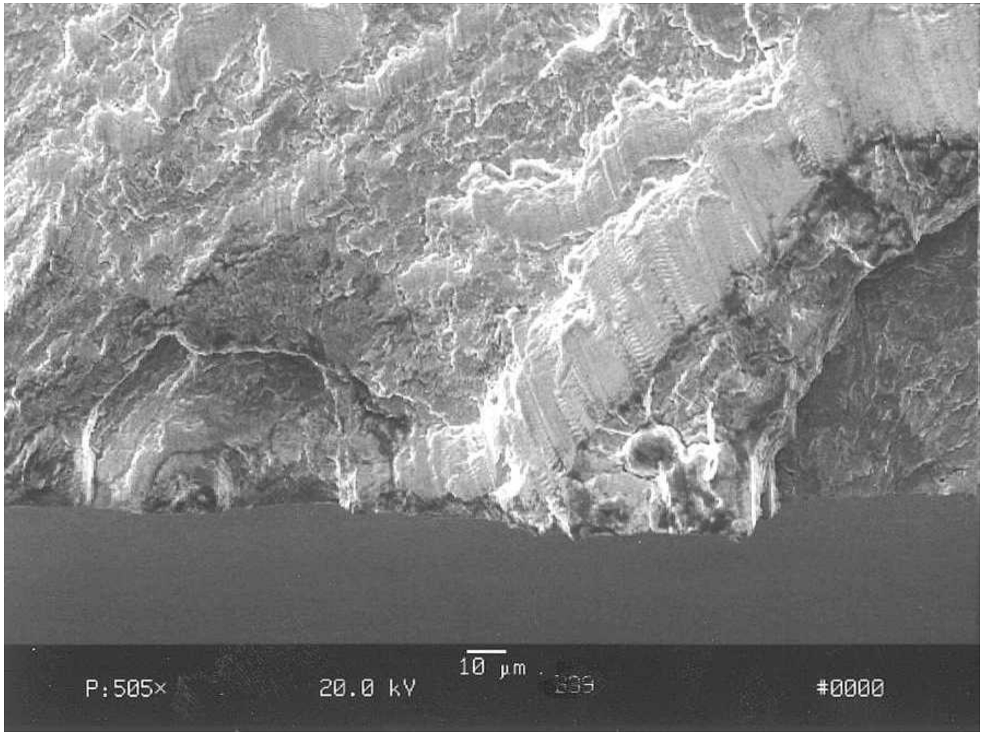
Photo #: 0604A00355, 060419-1, , 0.012 — 5 mils

Comment: Sample with CCAT parameter set from April 19, 2006. Using cutting parameters of 20 khz frequency, 25 pulse width, 100 mm/s, and cleaning parameters of 80khz pulse frequency 2.5 pulse wic and 500 mm/s. 2 cutting passes then 1 cleaning pass. Incrementing down in length and up in power v sucessive passes.

Creating Corrosion Pits

- Rely upon methods used in the rotorcraft and propeller industries.

- Coat specimen with wax
- Scratch through wax where pits are wanted
- Immerse specimen in electrified salt-bath
- Pit depth varies with immersion time

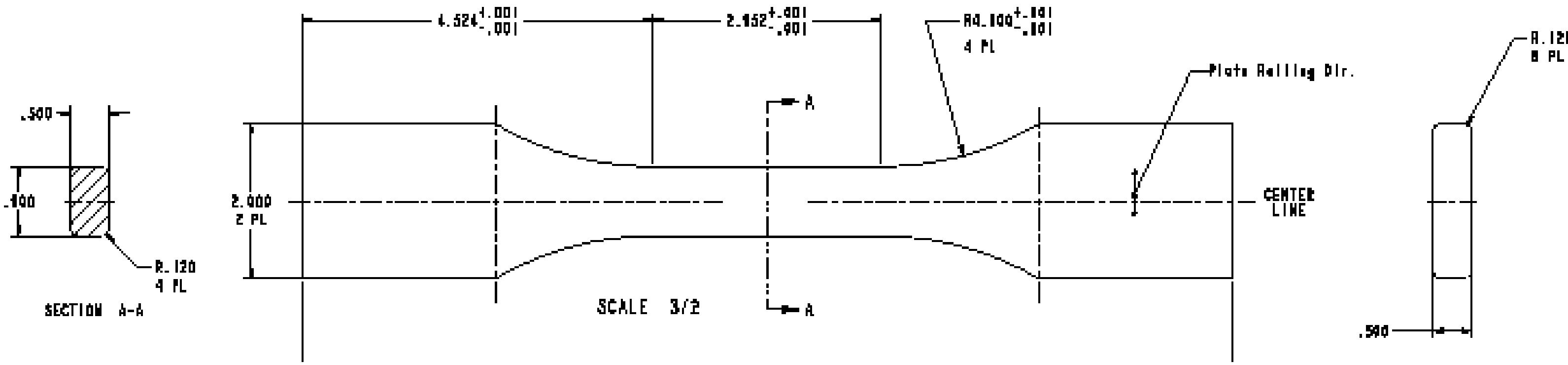


Test Plan

- Surface Crack Specimens
  - 7075-T7351 Al
  - D6AC Steel
  - Unpeened
  - Shot-peened
  - 60 to be tested at NASA JSC
  - 20 to be tested at FAA TC
- Corrosion Specimens
  - 7075-T7351 Al
  - D6AC Steel
  - Unpeened
  - Shot-peened
  - 60 to be tested at NASA JSC
  - 20 to be tested at FAA TC

All testing to be performed concurrently

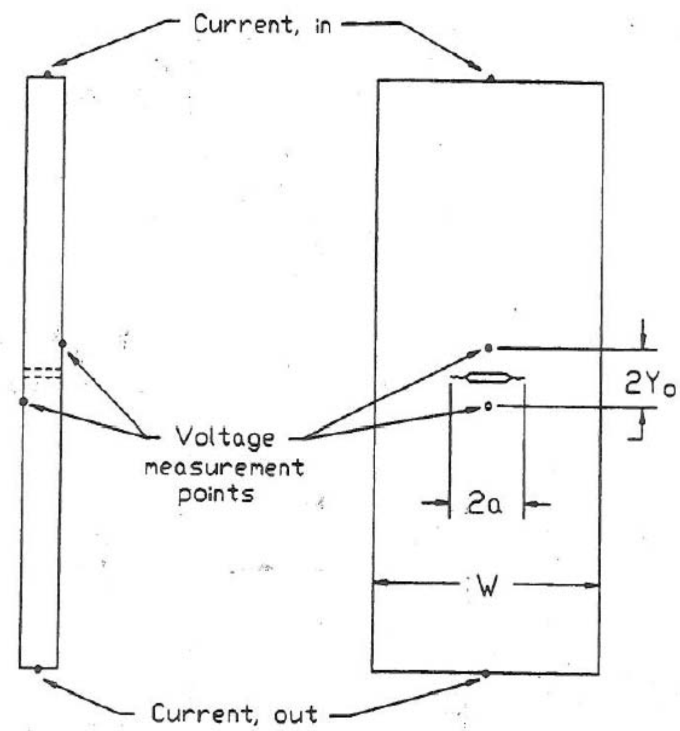
Laboratory Specimen



- **Damage**
  - **Laser-etched surface crack**
  - **Corrosion Pit**
- **Peening**
  - **Front and Rear Surfaces**

DC Potential Drop

- DC Current through specimen
- Measured resistance is equated to crack area
- Visual measurements on surface used to determine crack width
- Crack size and aspect ratio computed



Geometry and Electric Potential Wire Displacement Locations

Analysis

- Residual Stress Profiles
  - X-Ray
  - Hole Drilling
- Near Threshold Testing
  - Estimate threshold w/unpeened specimens
  - Compare to traditional C(T) data
  - Estimate threshold w/peening
  - Compare measured residual stresses to affect of peening on threshold

Analysis

- Develop K solution for pits
  - Use 3D boundary element method
  - Model pit morphology to get accurate K’s
  - Utilize modeled K values to compare to standard crack solution
- Corrosion vs. Crack
  - Compare SC data to pits in same materials and conditions
  - Compare pit data to traditional crack growth data

Summary

- Develop surface crack threshold data
- Develop corrosion pit threshold data
- Empirically define surface crack and corrosion thresholds in peened structure
- Compare surface crack and corrosion data to traditional threshold data
- Develop a method to qualitatively use threshold data for design